

Course guide

280820 - 280820 - Offshore Wind Turbines

Last modified: 27/05/2024

Unit in charge: Barcelona School of Nautical Studies
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: MASTER'S DEGREE IN NAVAL AND OCEAN ENGINEERING (Syllabus 2017). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: JOAN NICOLAS APRUZZESE

Others: Segon quadrimestre:
JOAN NICOLAS APRUZZESE - MUENO

PRIOR SKILLS

Knowledge of electrical machines, operation and applications.
Knowledge of electrical circuit theory

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

ENO_CEE2-2. Knowledge of the different modes of energy extraction from the sea (specific competence of the specialty in Ocean Energies)

ENO_CEE2-4. Knowledge of the methodology for the project of a wind turbine park (specific competence of the specialty in Ocean Energy)

ENO_CEE2-5. Knowledge of the different components of a marine wind turbine, as well as its functioning and operation (specific competence of the specialty in Ocean Energies)

ENO_CEE2-6. Capacity for the design and project of platforms for offshore wind turbines (specific competence of the specialty in Ocean Energy)

Transversal:

CT1. ENTREPRENEURSHIP AND INNOVATION: Knowing and understanding the organization of a company and the sciences that govern the activity; be able to understand the business rules and relationships between planning, industrial and commercial strategies, quality and profit.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Know and understand the complexity of economic and social phenomena typical of the welfare society, being able to relate welfare to globalization and sustainability; acquire skills to use in a balanced manner compatible technology, technology, economics and sustainability.

CT3. TEAMWORK: Ability to work as a member of an interdisciplinary team, either as a member or performing management tasks, with the aim of contributing to projects pragmatically and sense of responsibility, assuming commitments considering the resources available.

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty, and critically evaluate the results of this management.

CT5. THIRD LANGUAGE Learning a third language, preferably English, with adequate oral and written and in line with the future needs of the graduates.

Basic:

CB6. Possess knowledge and understanding that provide a basis or opportunity be original in the development and / or application of ideas, often in a research context.

CB7. That the students can apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their study area.

CB8. Students should be able to integrate knowledge and handle the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the responsibilities social and ethical linked to the application of their knowledge and judgments.

CB9. That students can communicate their conclusions and the knowledge and Latest rationale underpinning to specialists and non Specialty clearly and unambiguously.

CB10. Students must possess the learning skills that enable them continue studying in a way that will be largely self-directed or autonomous.

TEACHING METHODOLOGY

Acquire evaluation criteria of the technological viability and the possibilities of ocean wind energy conversion.

Analyze specific designs of technology to harness oceanic wind energy.

Develop attitudes and skills for planning and sizing wind turbine systems.

Carry out studies of technological feasibility of wind generation.

Analyze real applications.

Study cases and articles on subjects of the subject.

Carry out work individually.

LEARNING OBJECTIVES OF THE SUBJECT

To know the criteria for evaluating the potential and feasibility of offshore wind energy.

Develop capacity to apply existing technology and evaluate new technologies applicable to wind generation.

Have the ability to size the devices and installations associated with offshore wind systems.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	45,0	36.00

Total learning time: 125 h

CONTENTS

Topic 1: Offshore wind technology

Description:

- Introduction to the evaluation of resources.
- The offshore wind energy market.
- Elements that make up a marine wind turbine and basic characteristics.

Full-or-part-time: 13h

Theory classes: 4h

Guided activities: 4h

Self study : 5h

Topic 2: Considerations for the design, construction and installation of an offshore wind farm

Description:

- Definitions and basic concepts: power curve, C_p coefficient, Betz limit, temporal frequency and vertical wind distributions.
- Wind forces and how they affect.
- Aerodynamics of wind turbines.
- Types of wind turbines. Fixed speed and variable speed turbines.
- Introduction to the components of the aerial generators, subsystems.
- Types of electric generators.
- Behavior and analysis in steady and dynamic state, efficiency, operation and regulation. Modeling.
- Supports (foundations and anchors).

Full-or-part-time: 19h

Theory classes: 7h

Guided activities: 7h

Self study : 5h

Topic 3: Availability of the wind resource. Power prediction

Description:

- Management of an offshore wind project.
- Quantification of wind energy.
- Use of simulation methods to estimate wind energy production and when they are applicable.
- The efficiency of a wind turbine, determination of energy performance using real or approximate wind speed data.
- Organization and production of an offshore wind farm.
- Configuration and dimensioning, the wake effect between wind blades.
- Operation and profitability limits.
- Analysis of facilities built

Full-or-part-time: 21h

Theory classes: 8h

Guided activities: 8h

Self study : 5h

Topic 4: Connection of the park in a network and to the network. Electrical infrastructure

Description:

- Technologies, use and design criteria.
- Static converters of electrical energy. DC-AC and AC-DC converters.
- High voltage AC (HVAC) and DC (HVDC) links for transmission and evacuation of energy, cables for DC transport.
- System control and protection.
- Basic concepts of integration in the wind turbine network.
- Effects that wind energy has on the operation of the network.
- The Supergrid concept. Integration and interconnection of large offshore wind farms
- Analysis of facilities built and relevant projects.

Full-or-part-time: 29h

Theory classes: 12h

Guided activities: 12h

Self study : 5h

Topic 5: Operation and maintenance

Description:

- Project management
- Storms and adverse weather risks
- Environmental impact
- Auxiliary and internal management services
- Maintenance and life cycle of the installation
- Support vessels for installation and maintenance

Full-or-part-time: 17h

Theory classes: 6h

Guided activities: 6h

Self study : 5h

Topic 6: Operation and exploitation costs

Description:

- Project financing
- Costs
- Risks
- Insurance and financial management
- Different economic support schemes for wind energy.

Full-or-part-time: 13h

Theory classes: 4h

Guided activities: 4h

Self study : 5h

Topic 7: National and international regulations

Description:

- International context of marine renewable energies.
- Incentives for marine renewable energies.
- National, European policies.
- Electricity rates in Spain.
- Preferential lines of action

Full-or-part-time: 13h

Theory classes: 4h

Guided activities: 4h

Self study : 5h

GRADING SYSTEM

The final grade is the sum of the following partial grades:

$$N_{\text{final}} = 0.2N_f + 0.2N_p + 0.6N_c$$

N_{final} : Final qualification

N_f : Final evaluation score

N_p : Partial evaluation qualification

N_c : Continuous assessment qualification (Participation in class activities, assignments, exercises, presentations.)

EXAMINATION RULES.

Attendance at the tests is compulsory. Participating in the activities carried out during the course, carrying out exercises and presentations in classes, are decisive in the continuous assessment mark.

BIBLIOGRAPHY

Basic:

- Heier, Siegfried. Grid integration of wind energy : onshore and offshore conversion systems [on line]. 3rd ed. Chichester: Wiley, 2014 [Consultation : 01/09/2022]. Available on : <https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781118703274>. ISBN 9781118703304.
- Wildi, Théodore. Electrical machines, drives, and power systems. 6th ed. Essex: Pearson Education, 2014. ISBN 9781292024585.
- Ackermann, Thomas. Wind power in power systems [on line]. 2nd ed. Chichester: John Wiley & Sons, 2012 [Consultation: 01/09/2022]. Available on: <https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781119941842>. ISBN 9780470974162.
- López Melendo, Jacinto. Calidad de potencia : armónicos y factor de potencia [on line]. [Barcelona]: Marcombo, 2018 [Consultation: 13/09/2024]. Available on : https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=11376. ISBN 9788426725714.

Complementary:

- López Mendizabal, Ramón [et al.]. Con el viento a favor = With a fair wind. [Madrid]: Fundación ESTEYCO, 2015. ISBN 9788494332425.
- Carta González, José Antonio [et al.]. Centrales de energías renovables : generación eléctrica con energías renovables [on line]. 2a ed. Madrid: Pearson, 2013 [Consultation : 30/05/2022]. Available on : https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1324. ISBN 9788483229989.
- Hau, Erich. Wind turbines : fundamentals, technologies, application, economics [on line]. 3rd ed. Berlin: Springer, 2013 [Consultation: 04/07/2019]. Available on: <http://dx.doi.org/10.1007/978-3-642-27151-9>. ISBN 9783642271519.
- Villarrubia López, Miguel. Ingeniería de la energía eólica [on line]. Barcelona: Marcombo Ediciones Técnicas, 2012 [Consultation: 01/09/2022]. Available on : <https://web-p-ebshost-com.recursos.biblioteca.upc.edu/ehost/ebookviewer/ebook?sid=93b851e4-5e0d-4b1c-9105-a157f7498b60%40redis&vid=0&format=EK>. ISBN 9788426718563.
- Rashid, Muhammad H; Navarro Salas, Rodolfo; El Filali, Brahim. Electrónica de potencia [on line]. Cuarta edición. México, D.F.: Pearson, 2015 [Consultation : 13/09/2024]. Available on : https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6191. ISBN 9786073233286.
- Pozo Ruz, Ana. Convertidores Conmutados de Potencia : Test de Autoevaluación [on line]. Second edition. Barcelona: Marcombo, 2017 [Consultation : 13/09/2024]. Available on : <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=31307067>. ISBN 9788426734341.